(12) UK Patent Application (19) GB (11) 2 094 896 A

(21) Application No 8207445
(22) Date of filing 15 Mar 1982
(30) Priority data
(31) 8105084
(32) 13 Mar 1981
(33) France (FR)
(43) Application published
22 Sep 1982
(51) INT CL³
F04D 29/28
(52) Domestic classification
F1V 102 210 B
B3G 19A
(56) Documents cited
GB 1308541
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GB 0849744
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GB 0584056
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(58) Field of search
F1V
B3G
F1T

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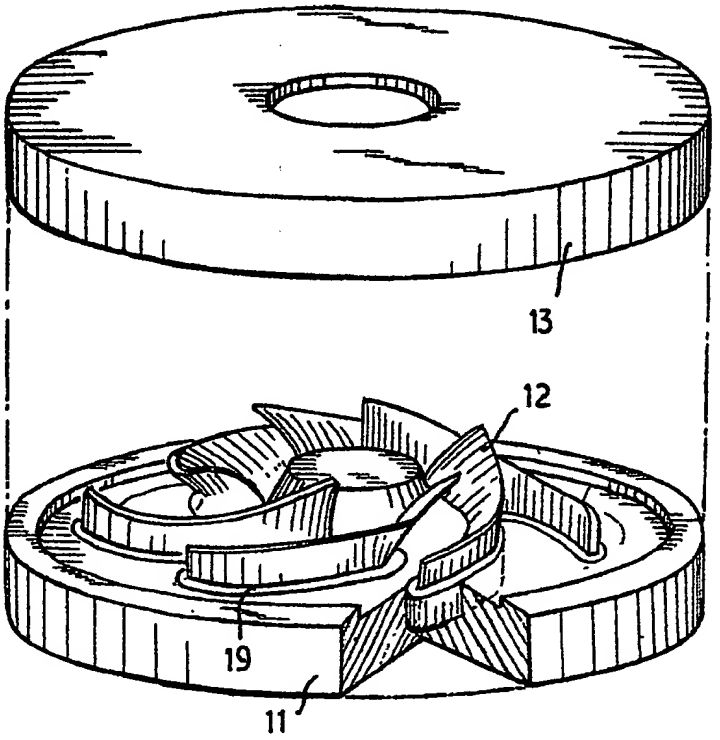
(54) **Impellers and processes for producing them by moulding**

(57) A pump impeller comprises a hub surrounded by a web which is a surface of revolution about, and whose imaginary projection intersects, the hub axis, the web carrying helico-centrifugal vanes with both faces of each vane parallel and formed as acute helicoids about the hub axis. The impeller is made by constructing a plastic pattern having vanes 12, using the pattern to form a sand mould, withdrawing the pattern from the sand with a helical movement and then filling the mould cavities with liquid metal.

FIG.4



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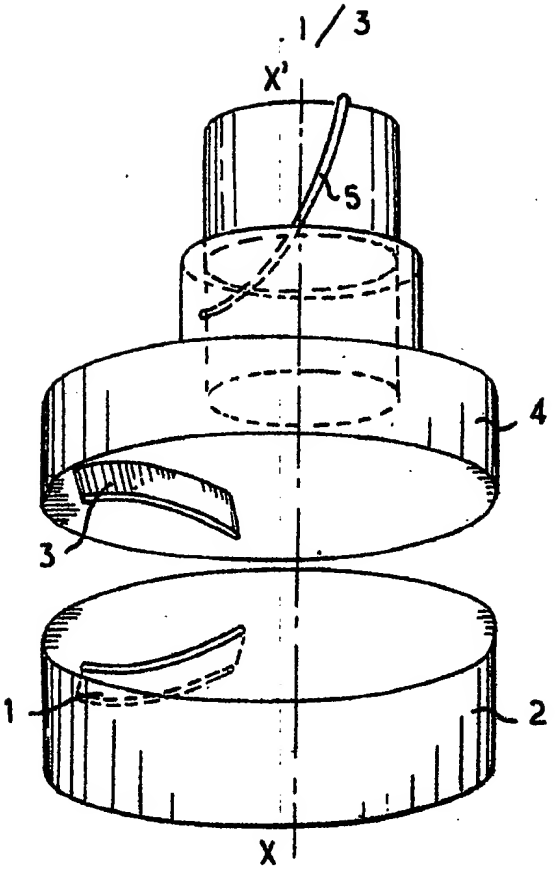

FIG.1

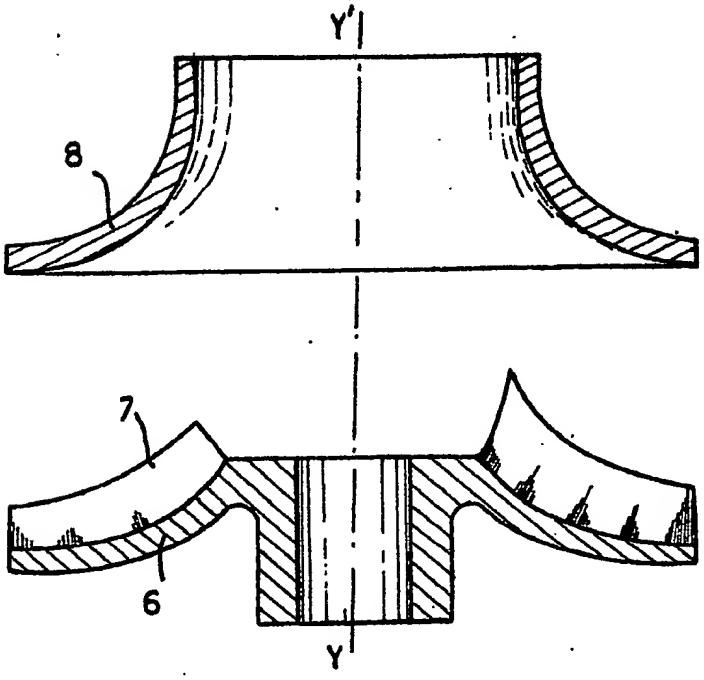

FIG.2

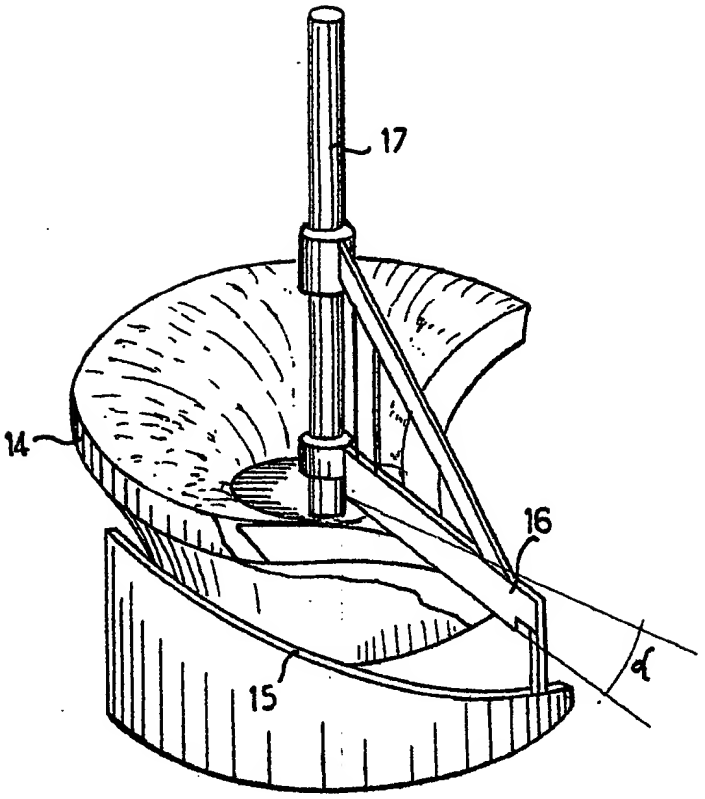

FIG.3

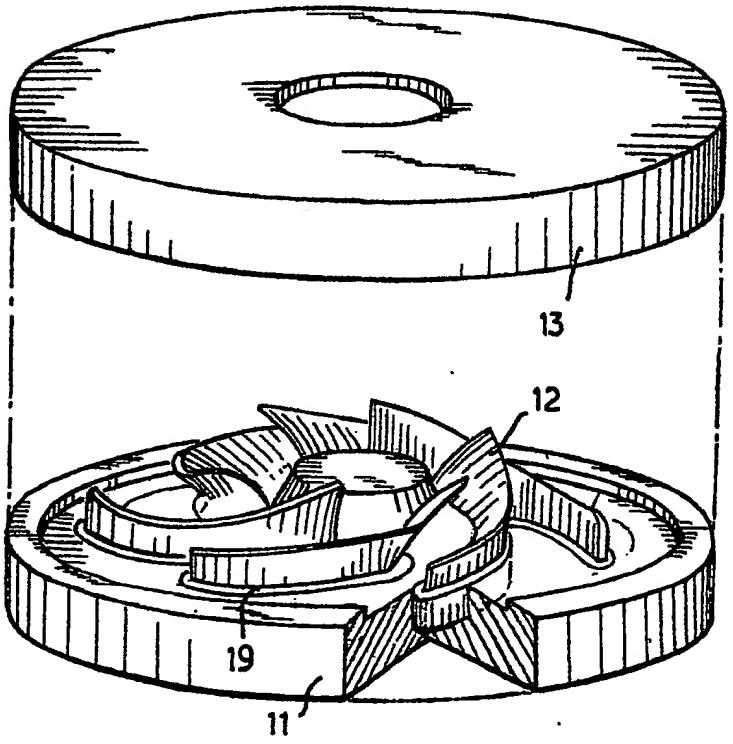

FIG.4

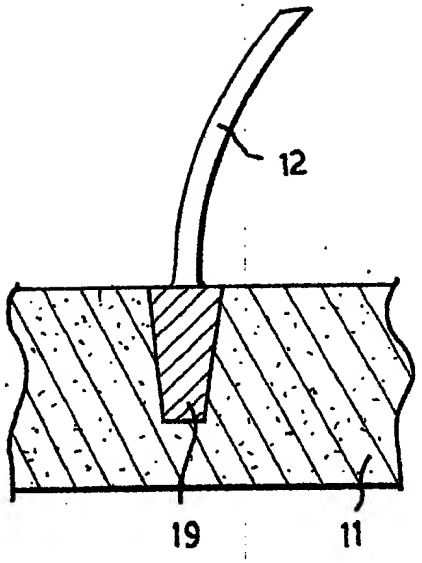

FIG.5

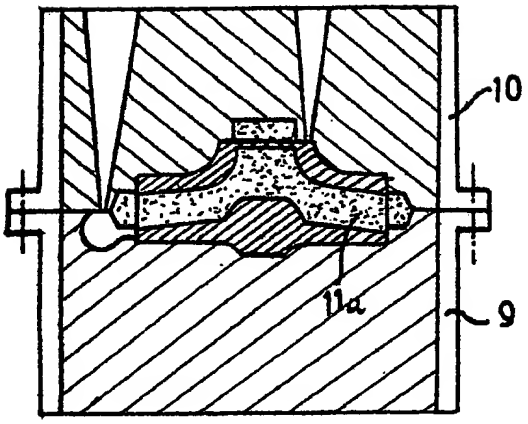

FIG.6

SPECIFICATION

Vane wheels, and equipment and processes for making them by moulding

The present invention relates to vane wheels and to equipment and processes for making them by moulding.

There are three distinct types of vane wheels: those called centrifugal (or centripetal) radial vane wheels, where the paths of the fluid particles are contained in planes perpendicular to the axis of rotation, except in the immediate vicinity of the latter; those called axial vane wheels, in which the fluid particles remain substantially at a constant distance from the axis of rotation; and those called helico-centrifugal (or helico-centripetal) vane wheels, which come between the two preceding cases, and in which the vanes are shaped so that the fluid particles follow a path which has both a radial component and an axial component. It is this last type of wheel which the invention improves.

The outline of the vanes of these wheels is governed by hydraulic factors which define, in particular, their angle of entry, angle of exit, length, height, leading edge and profile. The vane which results from this has a complicated skew shape. It cannot be removed from a mould. To produce it in a foundry, sand cores are made by assembling sectors which are held together by bonding and by tying. These assemblies give a casting which has many burrs, thus making it necessary to remove these burrs subsequently, and its dimensions are neither exact nor reproducible and its surface state is very mediocre. When the curves of the vanes are slight, a one-piece core is used, and the core maker loosens the fins of the core case to move them from the core during preparation of the latter. Consequently, not only do the cores no longer comply with the dimensions fixed by the hydraulic engineer and differ from one another, but also the hydraulic engineer does not know this difference in dimension, and it varies in an unforeseen manner from one vane to another on one and the same wheel, according as the movement of the caster is more or less abrupt. The manufacturer of helico-centrifugal vane wheels does not known the actual profile of the vanes, although he has determined the theoretical profile with a great degree of accuracy, and because of this uncertainty in production he is prompted to adopt larger tolerances.

The invention overcomes these disadvantages by means of a helico-centrifugal vane wheel, the surface state of which, when obtained from casting or moulding, is flawless, the dimensions of which are accurate and can correspond exactly to the plans given to the caster, without insuperable difficulties facing him, and the production of which is quicker than in the past and can be automated. Experience has shown that this vane wheel gives at least the same performance as conventional helico-centrifugal wheels and often performances higher than these.

The subject of the invention is a vane wheel formed by a hub surrounded by a web which is in revolution about the axis of the hub and from which project helico-centrifugal vanes with parallel lower faces and upper faces and adopting the axis of the hub as an axis of repetition, characterised in that the imaginary prolongation of the generating line of the web intersects the axis of the hub, and the lower faces and upper faces of the vanes extend as a whole along portions of acute helicoids, the common axis of which is that of the hub.

Preferably, the web is substantially conical, and the acute angle between the radius vector of a helicoid and the axis of the latter is equal to the angle of the hub.

The expression "acute helicoid" denotes a helicoid of which the angle between the radius vector and the axis of revolution is acute, instead of the radius vector being perpendicular to the axis. In this way, the angle of entry is preserved exactly, and this is of great importance from a hydraulic point of view.

It will be understood that such a vane wheel made of plastic can easily be removed from a mould, and the moulding process involves producing a mould, the cavities of which are delimited by portions of acute helicoids of the same axis, filling these cavities with liquid plastic, making the plastic harden into a rigid piece, and removing the rigid piece from the mould, giving it a helical movement about the axis of the helicoids.

The surface state is flawless, as is the accuracy of the dimensions, and the mould-release operation can be automated by means which impart a helical movement about the axis of the helicoids to the piece located in the mould.

With regard to a vane wheel obtained by casting, the process consists in producing a sand core in which cavities are made with the shape of the vanes of the wheel to be moulded, filling these cavities with liquid metal, leaving the metal to solidify in one piece, and destroying the sand core to release the piece, and this process is characterised in that it consists of producing a core case which has vanes, the lower faces and upper faces of which extend along portions of acute helicoids of the same axis, filling the core case with sand, hardening the sand in this into a core, and removing the core from the case, giving the vanes of the latter a helical movement about their axis.

In the attached drawings given solely by way of example:

Figure 1 is a perspective diagram of a mould according to the invention.

Figure 2 is an exploded sectional view of a vane wheel according to the invention.

Figure 3 is a perspective view illustrating the production of a core case according to the invention.

Figure 4 is an exploded perspective view, with a partial cutaway, of a core case.

Figure 5 is a sectional view of a vane of a core case; and

Figure 6 is a sectional view of a mould incorporating a sand core according to the invention.

To produce a mould for vane wheels made of plastic, cavities 1 of the same axis of repetition XX' (only one of these cavities is shown) are made in a metallic former 2 by means of an electrode 3 as a result of electro-erosion. The opposite faces of the electrode 3 extend along portions of acute helicoids of axis XX". The electrode 3 is carried by an electrode-holder 4 which is driven step by step in a helical movement of the same axis and of the same pitch as that of the helicoids, on a screw 5 by means which are not shown.

The former 2, provided with cavities 1, and a conical cap providing a hub constitute a mould. Removal from the mould is effected by giving the moulded piece of helical movement. A conical web 6 with a hub provided with vanes 7 is obtained (Figure 2), and it is sufficient to weld a closing web 8 on the edges of these by ultrasonics in order to obtain a vane wheel. The imaginary prolongation of the generating line of the web 6 intersects the axis YY' of the hub. The lower faces and upper faces of the vanes 7 extend along portions of acute helicoids of axis of YY'.

In casting, the wheel is made by means of two frames 9, 10, one lower and one upper, filled with sand and matching the outer shapes of the wheel, and, between the two frames, a sand core 11a reproducing the inner shape of the wheel (Figure 6). After the metal has been cast and cooled, the sand is destroyed, and the rough-cast wheel is obtained.

To produce the two frames and the core, it is necessary to have:

— two model plates reproducing the front faces and the rear face of the wheel,

— a core case (Figure 4) for making the core.

The model plates are obtained in the conventional way without difficulty.

The core case consists essentially of a case bottom 11, and assembly of vanes 12 and a cap 13.

The bottom 11 and the cap 13 are produced without difficulty. These are turned parts.

To make the assembly of vanes 12, the following procedure is adopted (Figure 3):

1) Production of a core former 14: this is a wooden piece which is turned and which represents the shapes between the front web and the rear web.

2) Production of a ramp 15 corresponding to the pitch of the helicoid.

3) Production of a knife 16 mounted on an axis 17 and inclined relative to the latter by the amount of the angle α of the helicoid. After a notch has been made without precision in the core former 14, it is stuck up by means of the knife 16 moving on the ramp 15. This knife thus traces the skeleton of the vane on a resin previously placed on the core former 14.

4) Production of the negative of the vane:

a) application on the skeleton of the vane of a calibrated wax of a thickness equal to half the thickness of the vane and representing the upper face.

b) An imprint of the upper face of the vane is taken by means of a casting resin.

c) A calibrated wax of a thickness equal to the thickness of the vane is applied to the imprint of the upper face of the vane.

d) An imprint of the lower face of the vane is taken by means of a casting resin.

By means of a succession of resin moulding operations, the negative of the vane positioned in the core former 14 is thus obtained.

This negative will make it possible to obtain final vanes and to position these vanes 12 on the bottom 11 of the case.

The vanes 12 are made either of resin and cast in the negative or of metal by the moulding in sand or a model obtained from the negative.

In both these cases, it is appropriate to add to the actual vane a portion called a locating stud 19 (Figure 5).

This "locating stud" is embedded in the case bottom 11 like a tenon in a mortice and will make it possible to put the vane 12 in place on the case bottom 11 and remove it from this.

The core case makes it possible to produce as many sand cores 11 as it is desired to make vane wheels. Each core 11a is located between the two frames 9, 10. The metal is cast. The case wheel is released by removing the sand.

It will be appreciated that the web in the form of a body of revolution may be a flat disc.

CLAIMS

1. Vane wheels formed by a hub surrounded by a web which is in revolution around the axis of the hub and from which project helico-centrifugal vanes with parallel lower faces and upper faces and adopting the axis of the hub as an axis of repetition, characterised in that the imaginary prolongation of the generating line of the web intersects the axis of the hub, and the lower faces and upper faces of the vanes extend as a whole along portions of acute helicoids, the common axis of which is that of the hub.

2. Wheel according to Claim 1, characterised in that the web is substantially in the form of a truncated cone.

3. A wheel according to Claim 1 or 2, characterised in that the acute angle between the radius vector of a helicoid and the axis of the latter is equal to the angle between the leading edge of the vane and the axis of the hub.

4. Process for moulding a vane wheel made of plastic according to one of Claims 1 to 3, characterised in that it consists in producing a mould, the cavities of which are delimited by portions of acute helicoids of the same axis, filling these cavities with liquid plastic, making the plastic harden into a rigid piece, and removing the rigid piece from the mould, giving it a helical movement about the axis of the helicoids.

5. Mould for putting the process of Claim 4 into practice, characterised in that it possesses cavities delimited by portions of acute helicoids of the

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